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Solutions for Problems of Chapter 1

1. Describe the difference between the model for design and that for analysis.

Analysis model is usually an abstraction of the design model and derived by removing unnecessary details, reducing dimension, and recognizing and employing symmetry.

2. Why is the analysis model different from the design model ?

The current computational power sometimes still cannot handle the design model as it is. Also, it is computationally much more efficient to use the abstraction of the design model.

3. What kinds of analysis work are involved in a design process ?

Stress analysis, interference checking, kinematic analysis, and so forth.

4. What are the roles of CAD tools?

- *Definition or creation of a design shape*
- *Mass property calculation of a shape*
- *Finite element modeling*
- *Visualization of the analysis results or post-processing*
- *Simulation of operation after calculating the motion of machinery*
- *Interference detection between parts in an assembly*

5. Among the roles in Question 4, which is the most important role and why?

Definition of a design shape is the most important role because the geometry of the design is essential to all the activities to follow in the product cycle.

6. Base on your answer in Question 5, list the most important kinds of the CAD tools.

Computer aided drafting system, Geometric modeling system including solid modeling system

7. What are the roles of CAM tools?

- *Generation of NC program*
- *Generation of a program to drive CMM (Coordinate Measuring Machine)*
- *Generation of process plan*
- *Generation of a program to drive robots*
- *Determine when to order raw materials and purchase parts and how many should be ordered*

8. Among the roles in Question 7, which is the most mature area?

NC program generation

9. Which advantage can we expect if the similar parts are grouped into a family by group technology concept?

We can generate a process plan for a specific part in the family by slightly modifying the standard process plan that has been set up in advance for the whole family.

10. What is the main advantage of using CAE tools in the design process?

It allows the designer to see how the product will behave and catch any errors before spending all the time and expense for building and testing prototypes.

Solutions for Problems of Chapter 2

1. List the components of a graphics device and explain the role of each component.

- *Display device:* Screen on which graphic image appears.
- *Display processing unit:* Accepts the signals corresponding to the graphics commands, produces the electron beams, and transmits them to the proper locations on the monitor so that the desired image is generated.
- *Input device:* Facilitates the interactive shape manipulations by allowing the user to provide the graphics inputs directly to the computer.

2. Explain the reason why refresh is required in vector-refresh or raster graphic device.

Without refresh, the light emission by the phosphor continues only a very short time and the image will disappear right away.

3. Explain how animation can be realized in a vector-refresh graphics device.

Changing the contents in the display buffer is changed continuously while the display processing unit is reading each line of the display buffer will result the continual modification of the image.

4. Explain the reason why flickering does not occur in raster graphic device regardless of the image complexity.

The scanning pattern of the electron beam is constant all the time, and the time required for the refresh is constant regardless of the complexity of the image.

5. Consider a raster graphic device composed of 12 bit planes, i.e. 4 bit planes for red, 4 bit planes for green, and 4 bit planes for blue. How many colors can be displayed simultaneously on this device?

2^{12} colors

6. List the advantages of the hardware configuration composed of net-worked engineering workstations.

- *System performance for each user is independent of the other users.*
- *Can avoid the large investment during the training period.*
- *Can try various CAD/CAM/CAE software for training purpose because the software running on workstation is cheaper.*

7. List the 2D drafting software available in your environment.

AutoCAD R14, MicroCADAM, CADAM Drafting, IntelliCAD98, etc.

8. List the geometric modeling systems available in your environment.

Pro/ENGINEER, Unigraphics, CATIA, I-DEAS, DesignBase, SolidWorks, Solid Edge, Mechanical Desktop, Helix Modeling, CADKEY, Microstation Modeler, etc.

- 9. List the CAM software available in your environment. Briefly describe the function of each software.**

Pro/MFG, Pro/NC-CHECK, Pro/NCPOST: Generates NC tool paths directly from CAD models, simulates NC sequences, and finally generates machine code (G-code).

BravoNCG, MasterCAM, SmartCAM, CAMWorks, VERICUT, Camand, PowerMILL, etc.

- 10. List the CAE software available in your environment. Briefly describe the function of each software.**

Pro/MECHANICA , ANSYS, MSC/NASTRAN, DesignWorks: Finite element analysis program.

ADAMS: Solves multi-body dynamics for motion simulation.

Solutions for Problems of Chapter 3

1. What are the disadvantages of a graphics program written directly with the device driver commands?

- *Machine dependent. The program has to be rewritten if a different graphics device needs to be used.*
- *Each device driver commands has only a primitive capability and the graphics program written with them would have a long list of the commands. This will result a bad readability of a program.*

2. Explain the reason why a graphics program written using a graphics library runs on a limited types of graphics devices.

Any graphics library has only a finite number of device drivers inside.

3. What is the main reason of using the virtual device coordinate system in specifying a location in a graphics device instead of the device coordinate system?

A location specified by the values in reference to the virtual device coordinate system would always occupy the same location regardless of the type of the graphics device.

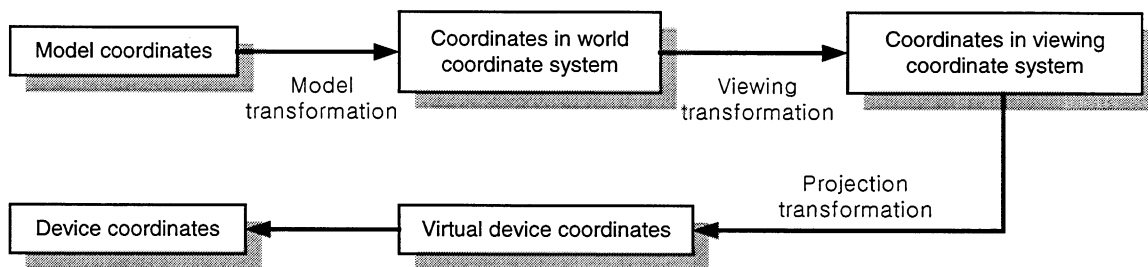
4. What is the reason of using the model coordinate system attached to an object in describing the shape of the object?

If the coordinates of any point on an object are defined with respect to the object's model coordinate system, their values do not change even when the object is translated or rotated in the space. They are determined solely by the shape of the object.

5. Explain how the location and orientation of each object in a scene is specified.

The location and orientation of an object is equivalent to those of the model coordinate system of the object. Thus specifying the transformation matrix of the model coordinate system of each object with respect to a common world coordinate system will describe the relative location and orientation of objects in a scene.

6. Briefly describe the procedure in which the coordinates of a point on an object, measured with respect to its model coordinate system, are converted to the screen device coordinates.



7. Explain the meaning of “window” used in computer graphics.

Window is a rectangle in space and used to specify the viewing volume. Viewing volume is determined by sweeping the four vertices of a window in the direction of projection. Viewing volume is used to clip the objects in a scene such that the portions of the objects outside the viewing volume are not displayed.

8. Explain the meaning of “viewport”.

The viewpoint is an area on a display monitor where we want the projected image to appear. It is an area to which the viewing volume defined by the window is mapped.

9. Explain the difference when a mouse is used in the picking mode from when it is in the sampling mode.

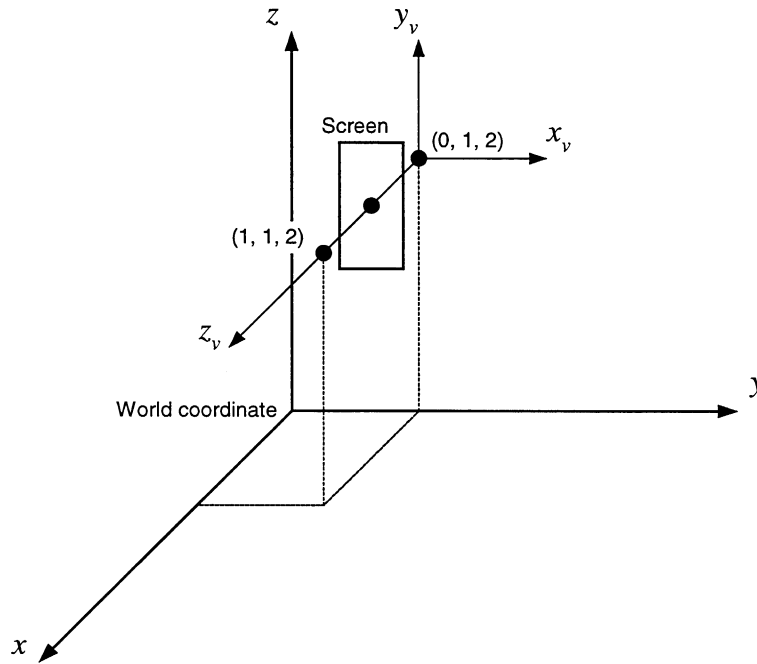
The graphics input device in a picking mode delivers the identification of the graphics element that is overlapped by a cursor at the time when the mouse button is pushed. In sampling mode, it delivers the location of the mouse or the corresponding location of the cursor regardless of the action on the button.

10. What kinds of operations can be done when graphic elements are defined to be a display list?

- *The whole elements in a display list can be imbedded in a parent display list at many places and can be executed many times.*
- *The whole elements can be scaled, translated, and rotated.*
- *The whole elements in a display list can be executed hierarchically.*
- *The whole elements can be deleted.*

11. The locations of the view point and the view site are specified to be (1, 1, 2) and (0, 1, 2) respectively with respect to the world coordinate system. Similarly, up vector is (0, 0, 1) with respect to the world coordinate system.

- (a) Show the relation between the screen, the viewing coordinate system, the view point, and the view site in sketch.



- (b) Derive the transformation matrix T_{w-v} that transforms the coordinates in world coordinates to those in viewing coordinates.

The first three numbers in the first column of T_{w-v} (i.e., n_x , n_y , and n_z) are $(0, 0, 1)$ because they are the x_v , y_v , and z_v components of the x_w axis. Similarly, o_x , o_y , and o_z , which are the x_v , y_v , and z_v components of the y_w axis, are $(1, 0, 0)$, and a_x , a_y , and a_z are $(0, 1, 0)$. Because p_x , p_y , and p_z are, respectively, the x_v , y_v , and z_v coordinates of the origin of $x_w y_w z_w$ coordinate system, their values are -1 , -2 , and 0 , respectively. Therefore we can derive T_{w-v} as follows.